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AUTHOR Kesner, Miri; Hofstein, Avi; Ben-Zvi, Ruth
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ABSTRACT

This paper reports on part of a five-year research study on the implementation of new industrial chemistry case studies into the curriculum for students majoring in chemistry in Israeli high schools. The purpose of the study was to obtain information on teachers' formal education in industrial chemistry and their attitudes toward teaching this subject. The study also addresses the expectations of the teachers from inservice training and its contribution to their needs. The data for this study consist of informational and attitude questionnaires which were followed by interviews. Findings suggest that the traditional training of chemistry teachers hardly touches on the subject of industrial chemistry and that many teachers had taken no industrial chemistry courses or visited a chemical plant prior to inservice training. (DDR)

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Reflections on teachers' in-service training while introducing a new teaching unit on industrial chemistry to the chemistry curriculum in Israeli high schools

Miri Kesner, Avi Hofstein and Ruth Ben-Zvi, The Weizmann Institute of Science, Rehovot, Israel

This paper is part of a five year research study on the implementation of new industrial chemistry case studies in the chemistry curriculum for students who major in chemistry in Israeli high schools. It focuses on teachers trained to teach these topics. The purpose of the study was to get information on teachers' formal education in industrial chemistry and their attitude to teaching this subject. It also dealt with the expectations of the teachers from the in-service training and of its contribution to their needs. This information was needed to plan an effective in-service training. The study included informational and attitude questionnaires followed by interviews. It was found that the traditional training of chemistry teachers at the university or teachers' training colleges hardly touched upon the subject of industrial chemistry. A relatively high percentage of teachers had taken no industrial chemistry course or visited a chemical plant before they reached our in-service training. This might be the explanation why many teachers felt insecure and unable to teach the subject in their classes. The statistical results show that in several respects the courses satisfied the teachers' expectations and gave us ideas how to improve future in-service training courses.

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Background

In recent years, it has been suggested, that more emphasis should be put on the importance of science to everyday life and the integral role it plays in industry, technology and society(Yager, 1992).

There is no doubt that the chemical industry provides an opportunity to introduce to high school chemistry students general subjects in an interesting, relevant and useful way (Hofstein, 1985) so that the principles of chemistry can be combined with problems of technology, economics and the environment. Basic concepts of industrial chemistry can be presented through various case studies (Kesner, Hofstein, & Ben-Zvi, R.,1997a). The interdisciplinary approach can be used to help the students understand the overall concept of the industrial endeavor and to prepare them as future citizens to be able to think objectively on these issues. In the summer of 1989 we conducted a 3 day course for a small group of teachers on this subject. A preliminary study with this group indicated that about 40% of the teachers had no background at all in industrial chemistry and most of the others had very limited experience in this subject. Since 1991, students in Israeli high schools, who opt to major in chemistry in the 11th and the 12th grade have to take one out of two industrial case studies (Kesner 1988, Kesner 1990). Since a topic on industrial chemistry became obligatory there was an immediate need to train as many teachers as possible to successfully implement this new subject on industrial chemistry in their classroom. It was decided to conduct short intensive courses for teachers (4-5 days during the summer vacation).

The purpose of the study

In order to plan the courses there was a need to get information on teachers' knowledge on the subject, their attitudes and expectations from the in-service training. We also wanted to know how effective the courses were in order to improve them.

This study was a part of a wider evaluation research done during the implementation of the new industrial chemistry case studies in the chemistry curriculum (Kesner, Hofstein, & Ben-Zvi, R.,1997b). This particular part of the study focuses on the chemistry teachers who were trained to teach these new topics in their classes.

The purposes of the study were to get information on:

a. Teachers' formal education on industrial chemistry .

b. Teachers' attitudes to teaching industrial chemistry topics.

c. Teachers' expectations of the in-service training course.

d. Feedback on teachers' attitudes after taking the in-service training courses.

This information was needed in order to plan an effective and improved model for an in-service training course (Kesner, Hofstein, & Ben-Zvi, R.,1997a).

Components of the in-service training courses (1990-1994)

In-service training during the years of 1990-1994 were planned mainly to give the teachers sufficient background on industrial chemistry and the contents of the teaching units (Kesner, Hofstein, & Ben-Zvi, R.,1997a). The main components of the courses were:

a. A general lecture on chemical industry in Israel.
b. A lecture describing the contents of the teaching units and also relevant basic important industrial chemistry concepts.
c. A lecture on preparing students for a visit to a chemical plant.
d. A visit to a chemical plant.
e. Enrichment lectures given by industrialists emphasizing the unique way of thinking in industrial issues.

Research sample

Five courses were conducted during the summers of 1990-1994. Approximately 30 teachers participated in each course. Personal information questionnaire was given to all teachers. The closed part (expectations ,contribution) was given only since 1991 (three groups), We could not analyze the 1994's data because an insufficient number of teachers returned the post test questionnaire.

Instruments

This study was conducted both qualitatively and quantitatively and included:

I. Personal information questionnaire

The Personal information questionnaire given to the teachers prior to the course included questions such as:

- What is your academic degree?
- Have you participated in an industrial chemistry course during your academic studies ?
- Have you visited a chemistry plant during your academic studies?
- For how many years have you been teaching?

II. An attitude questionnaire consisting of several parts:

This questionnaire included several parts:

a. An open part (given pre and post) including questions such as:

- What problems, in your opinion, have chemistry teachers in teaching industrial chemistry subjects?

- Describe in short sentences your personal feeling to teaching industrial chemistry subjects?
- What subjects do you think should a teacher training course include in order to be able to teach industrial chemistry subjects?

b. A closed part asking about the teachers' expectations from the course(pre) and contribution of the course (post).

This part included a Likert type questionnaire with 1-5 scale (1-definitely do not agree to 5-definitely agree). The teachers were asked to note their degree of agreement with the importance of the following components of an in-service course. This part of the questionnaire was given twice, at the beginning of the course (expectations) and at the end of the course (contribution).

1. Studying the contents of the teaching units
2. Acquiring background knowledge in industrial chemistry subjects.
3. Studying about industrial chemistry in general.
4. Visiting a chemistry plant.
5. Learning how to organize a visit to a chemistry plant.
6. Learning how to prepare the students for a visit to a chemistry plant.
7. Learning about teaching methods for the implementation of industrial chemistry topics in class.
8. Learning how to get the students interested in industrial chemistry subjects.
9. Learning how to vary teaching methods.
10. Solving problems in industrial chemistry subjects.

These 10 statements covered four categories: subject matter, the visit to a chemical plant, teaching methods, examination questions.

III. Post-course interviews.

Results

I. Personal information questionnaire given to the teachers before the course.

For these questions frequencies of the specific categories are presented.

The academic qualifications of the teachers were constant during the 5 years of the study:

B.Sc. in chemistry - about 45%.

Msc in chemistry - about 40%.

Ph.D. in chemistry - about 5%.

The remaining 5% studied biology, biochemistry, chemical engineering etc.

The results showed that 77% of the teachers that came to our courses had 6 or more years of teaching experience.

The following table gives the results (percentage of teachers) concerning the questions about participating in an industrial chemistry course and visiting a chemistry plant during the academic studies:

insert here table 1

It is evident that the same trend is kept through all the years. About 52% percent had no course and about 40% had no visit. About 32% percent of teachers had no course and no visit at all.

II. An attitude questionnaire:

a. The open part:

- What problems, in your opinion, have chemistry teachers in teaching industrial chemistry subjects?

The main problems that were mentioned by the teachers repeated themselves:

We have no basic education on chemical engineering and industrial chemistry.

We have no knowledge of chemistry plants.

A wider knowledge than just chemistry is needed in subjects such as economy, technology etc. .

Teaching industrial chemistry requires a new way of thinking: no more single solutions to each problem but "compromise" solutions.

We don't know how to teach such an interdisciplinary subject.

It is difficult to get up-to-date information.

We don't have close acquaintance with the subject in order to teach it enthusiastically.

It is difficult to organize a visit to a chemical plant.

- Describe in short sentences your personal feeling to teaching industrial chemistry subjects?

Teachers mainly wrote about feelings such as:

Lack of confidence because of insufficient knowledge in the subject matter.

Frustration because of being unable to acquire the requested knowledge.

Fear that the subject will be boring to the students.

But many of them wrote that:

The subject is important and enriching.

Contributes to the understanding of general principles of chemistry.

Develops a positive attitude to "applied chemistry".

Motivates the students to study.

Makes chemistry relevant

And added that:

It is difficult.

It demands special training.

There are many difficult things to understand.

It demands a lot of time.

-What subjects do you think should a teacher training course include in order to help teachers to teach industrial chemistry subjects?

General background on industrial chemistry in Israel and in the world at large.

The language of industrial chemistry.

How we scale up from a laboratory experiment to an industrial facility.

Getting to know industrial considerations beyond the chemical questions.

Learning about teaching methods.

How to organize a visit to a chemical plant.

How to teach it interestingly.

To meet people from industry.

To solve examination problems .

b. A closed part asking about the teachers' expectations from the course(pre) and contribution of the course (post).

In comparing both groups on the items of describing their expectations (pre) and on the items describing their contributions (post), almost no significant difference was found. Therefore we present here the combined results of 45 teachers. We calculated the mean scores for each item in the pre test and in the post test and used Wilcoxon test to compare them.

The following graph: gives the results concerning the 10 items (statemenrs):

insert here graph 1

The stars point out those items on which a significant difference between pre and post means exists.

In five out of ten items we found a significant difference between pre and post means. In items 3 and 4 the **post** means were significantly higher than the pre means. This shows that in studying industrial chemistry in general and visiting a chemistry plant, the contribution was above expectations. In contrast to these results in items 7, 8, 10 the **pre** means were significantly higher than the post means. This shows that in studying about teaching methods, learning how to get the students interested in industrial chemistry subjects or solving examination problems the contribution of the course was below expectations. In all the other items no significant difference was found between pre and post scores. This means that in studying about the contents of the teaching units, acquiring background knowledge in industrial chemistry subjects, learning how to vary

teaching methods, learning how to organize a visit to a chemistry plant and learning how to prepare the students for a visit the contribution satisfied the expectations. The expectations mean scores were originally higher than 3 (the median score) and so were the contributions mean scores.

III. Interviews after to the course.

It was observed that having teachers involved in the in-service training courses decreased their anxiety and reluctance to teach these new units on industrial chemistry. Direct quotes from some of the teachers are as follows(Kesner, Hofstein, & Ben-Zvi, R.,1997a): *"The industrial subject appeared to me to be overwhelming to teach. After the in service training course I am stimulated to study the subject and it actually seems to me to be one of the most important subjects in the whole curriculum". "After the training it was so easy for me to get prepared for teaching in class. Suddenly things appeared to be much more organized. I could read the book easily, and understood all of the different aspects."*

Application of research finding to the teachers in-service training

- The results helped us to rebuild the model for the short intensive courses. In addition to the components a-e of the course that were mentioned above we added the following components:

  f. Presentation of teaching methods and activities.

  g. Analyzing matriculation examination questions.

  h. A final project.

  The teaching methods component became very important and part of the activities were even experienced by the teachers. The final project gave the teachers the opportunity to explore individually or in groups certain problems in the chemical industry in order to get first hand experience in the subject.

  It was found to be very effective in decreasing the psychological barrier of coping with a new subject that has to be taught in class. Some of the teachers even developed new classroom activities of their own.
- We started to conduct workshops for small groups of teachers (Kesner, Hofstein, & Ben-Zvi, R.,1997a) in order to develop more teaching strategies and teaching instruments. The updated, newly developed teaching methods were included later on in the in-service training and in the teachers' guide (Kesner, 1994). The guide gave more teachers the possibility to improve their ability to teach industrial chemistry even when attendance at workshops is not possible.
- A Chemical Industry - Education Center has been established in the Department of Science Teaching in the Weizmann Institute of Science (Hofstein and Kesner, 1996). This center was funded by the Chamber of

Chemical Industry in the Israel Manufacturers Association and by the Israeli Chemical Ltd. (ICL).

Summary

Traditional training of chemistry teachers at the university or teachers' training colleges hardly touches upon industrial chemistry. Even in the rare cases where teachers have an appropriate background, up-to-date information on industrial chemistry is not readily available. For this reason, many teachers feel unable d to handle the many facets that such an interdisciplinary program touches upon. As a result, they are reluctant to teach such courses.

Teacher training is indispensable in any subject and it is especially important when training teachers to implement new teaching units which demand an interdisciplinary approach. The study helped us gain more insight into the teachers' difficulties and the efficiency of our in-service training courses which are planed to overcome these difficulties. The results of this study showed that in many respects the courses helped the teachers overcome their reluctance to teach the subject and to reveal what aspects should be improved in further in-service training courses. It also reinforced the need to create an information center to help teachers implement industrial chemistry in the classroom.

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Table 1

No course- No visit	No course- Visit	Course- No visit	Course- Visit	Year
36.00	20.00	2.00	42.00	1990a
40.54	21.62	8.11	29.73	1990b
51.43	17.14	5.71	25.71	1991
26.67	23.33	13.33	36.67	1993
45.45	18.18	18.18	18.18	1994
32.18	20.11	8.05	39.66	Sum

Graph 1